About *Experiments and Observations on Electricity*

Commentary by I. Bernard Cohen

Binding, Collation, and Provenance

Spots on the Page

Benjamin Franklin
Experiments and Observations on Electricity

London, 1751

Benjamin Franklin's book, *Experiments and Observations on Electricity*, is one of the most important scientific treatises of the eighteenth century, the founding work establishing the new science of electricity. The importance of this book can be seen in the very fact that in Franklin's own century there were five editions published in English, three in French (in two separate translations), one each in German and in Italian, and a Latin translation was undertaken. In our own time there have been a scholarly edition in English and new translations into Russian and Spanish. It is hard to think of any other scientific book that was so widely read. Yet another index of the importance of Franklin's *Experiments and Observations* is the fact that it established the language that we still use in discussing electrical phenomena, including plus or positive, minus or negative, and electrical battery.

In the 1740s, when Franklin began his research on electricity, he was doubly prepared for a career in science. First of all, he had reached a position in life when he had leisure to devote himself to scientific research. Second, he had been well educated in science – especially the kind of experimental science set forth by Newton in his *Opticks*. Franklin had already been making experiments on heat and other subjects. Here, by the way, we must be careful not to confuse "education" in the sciences with formal schooling. Franklin was better trained in science and the art of making scientific experiments and drawing theoretical conclusions from such experiments than if he had learned science at one of the colleges in America or, for that matter, in Britain.

One of the features of *Experiments and Observations* that appealed to students and general readers was the simplicity and elegance of its style. The British chemist Sir Humphrey Davy told his students to study Franklin's book as a model of scientific prose. The "style and manner" of Franklin's "book on electricity," he said, "are almost as worthy of admiration as the doctrine it contains." Science, Davy concluded, appears in Franklin's expositions "in a dress wonderfully decorous, the best adapted to display her native loveliness."

The book is based on letters and scientific memoirs which Franklin sent from Philadelphia to two British correspondents, Peter Collinson and John Mitchell. Collinson was an English Quaker merchant who was a patron of the aspiring intellectuals and scientists of Philadelphia. He sent the Philadelphia Library Company (a subscription library founded by Franklin) some simple electrical apparatus with instructions on how to use it. Mitchell was a British-trained doctor who lived in Virginia, where he made a reputation as an amateur botanist. He returned to England in 1746 and became well known for his "Map of the British and French Dominions in North America" (London, 1755).

A primary reason why Franklin's book was so important was that it presented a large variety of important new experimental discoveries. One of the most sensational of the novelties contained in Franklin's book was his analysis of the "Leyden jar," the first capacitor or condenser, the action of which produced electrical effects on a grand scale. Additionally, the book presented Franklin's bold new theory of electrical action which, for the first time, enabled experimenters to make accurate predictions of the outcome of experimental manipulations in the laboratory. This theory, which transformed the subject of electricity into a proper science, is still used, with some major modifications, as the basis of our discussions of electrical phenomena today.

The Leyden jar consisted of a glass bottle coated on the outside with metal foil and filled with lead shot or water. Franklin showed that this device was essentially a pair of parallel conductors (metal foil and shot or water) separated by a non-conductor (the glass). The Leyden jar had the astonishing ability to store up and then discharge a prodigious amount of "electricity," thus enabling showman scientists to produce large-scale demonstrations for the delectation of their audiences. Franklin's analysis of the Leyden jar was hailed as a major discovery because the scientific world was puzzled by such a simple device producing so tremendous an effect.

Franklin's theory of electrical action is based on several postulates, of which the primary one is that there is an "electric fluid" (sometimes called an "electric fire") which is made up of particles that mutually repel one another but are attracted by the particles of "ordinary" or "common" matter. Electrically neutral bodies have a balance between their quantity of electrical fluid and common matter. In electrification, however, a body either gains or loses some electrical fluid and so has a superfluity (positive charge) or a deficiency (negative charge) of electrical fluid. A positively charged body, in Franklin's terms, is one that has gained excess electric matter, while a negatively charged body is one that has lost some of its normal electric matter. Clearly, a body that has lost some of its electric matter will attract electric fluid or a body that has an excess of electric fluid in an attempt to restore the balance. Similarly, a positively charged body will attract and be attracted by a negatively charged body. It is also obvious from the theory that the excess electric matter in two positively charged bodies will cause a force of repulsion. One deduction from Franklin's theory was that in the generation of electric charges one body (or set of bodies) must gain as much "electric fluid" as is lost by another body (or set of bodies). This generalization, known today as the principle of conservation of charge, was verified by Franklin in a large variety of experiments and observations.

Franklin's first communications on the subject of electricity took the form of letters addressed to Peter Collinson, reporting to him the experiments and discoveries being made in Philadelphia with the simple electrical apparatus that Collinson had sent to Philadelphia. When Franklin learned that his letters were being circulated in English scientific circles, these letters became more formal, becoming what the eighteenth century tended to call "epistolary discourses."

Once these letters had been printed, however, Franklin became acutely aware that – as letters – they had not specified in detail which of his fellow experimenters had made certain particular discoveries. This kind of assigning of credit would certainly have been a feature of these letters if Franklin had known that they were being treated as public epistolary discourses rather than as private communications to Collinson. Collinson, in fact, put the book together from Franklin's communications without even consulting Franklin, and he got a fellow Quaker, Dr. John Fothergill, to write a preface.

Accordingly, when Franklin went to England as colonial agent and, for the first time could produce an edition under his own supervision, he carefully added notes giving the credit due to his fellow experimenters. He also added a supplement of further letters and memoranda. This fourth edition also corrected some serious faults of the early editions, of which the most important were the transposition of certain letters and the assigning of erroneous dates. (These alterations are discussed in full in the 1941 edition of Franklin's book, cited below.)

A sample of one of the new notes giving credit to a co-experimenter reads:

> This power of points to throw off the electrical fire, was first communicated to me by my ingenious friend Mr. Thomas Hopkinson, since deceased, whose virtue and integrity, in every station of life, public and private, will ever make his Memory dear to those who knew him, and knew how to value him.

Another declares:

> These experiments with the wheels, were made and communicated to me by my worthy and ingenious friend Mr. Philip Syng.

Despite the great success of the Franklin's one-fluid theory, described above, there were certain problems. A primary deficiency in the theory, brought to Franklin's attention by his fellow experimenter Ebenezer Kinnersley, was that two negatively charged bodies repel (or seem to repel) one another. Franklin himself never found a satisfactory explanation for this form of repulsion. As a good scientist, however, he did not attempt to conceal the problem but (in the supplementary part of the later editions of his book) included a frank discussion of the problem, reading in part: "You know I have always looked upon and mentioned the equal repulsion in cases of positive and of negative electricity as a phenomenon difficult to be explained." Franklin noted, however, that there "are likewise appearances of repulsion in other parts of nature."

In one of the later letters, Franklin gave sound advice concerning experimental science. "Opinions are continually varying," Franklin wrote, especially "where we cannot have mathematical evidence of the nature of things; and they must vary." He added, with characteristic perception, "Nor is this variation without its use, since it occasions a more thorough discussion, whereby error is often dissipated, true knowledge is encreased, and its principles become better understood and more firmly established."

One reason why Franklin's book was so popular and the reason why he became one of the most famous scientists of his age was, of course, his lightning experiments and his invention of the lightning rod. Most history books, in fact, limit their presentation of Franklin's research in electricity to a single experiment – the celebrated electric kite. This not only denies to Franklin his role in the creation of modern electrical science, but reduces his magnificent contribution to the founding of a science of electricity to a single experiment that was not in any case Franklin's fundamental experiment on lightning. Most accounts of Franklin make it appear that his research, including the kite experiment, was a test to see whether the lightning discharge is an electrical phenomenon, but – as readers of Franklin's book will quickly discover – what he was testing was something quite different, namely, whether clouds are electrified. Furthermore, the electrification of clouds was not the primary subject of his research; rather this topic arose as an afterthought. Franklin came to study electrical phenomena because he found the subject a new and challenging one. He first encountered the topic in a lecture given in Boston by a Dr. Adam Spencer, incorrectly referred to in his autobiography a "a Dr. Spence." Franklin later purchased Spencer's apparatus and used it in his experiments. A second impetus toward this area of research came when Peter Collinson sent the Library Company the glass tubes and an account of some electrical experiments then in vogue.

One set of observations made by Franklin in his lightning studies were to prove especially important. He found that if a grounded pointed conductor (such as a needle held in the experimenter's hand) is brought near a charged body, this point will "silently" (as he said) draw off the charge. If the pointed conductor is not grounded this does not happen. Like many other experimenters, Franklin could not help but observe that the spark discharges he produced in his laboratory experiments resembled the appearance of a lightning discharge, but on a much smaller scale. Accordingly, he wondered whether one could make an experimental test of whether the lightning discharge is an electrical phenomenon.

Franklin was aware that he did not have the means of making a direct test to prove that the lightning discharge is an electrical phenomenon. He could, however, test whether or not clouds are electrified. If he could prove that clouds are electrified, then he could conclude that the discharge from cloud to cloud or from cloud to earth is an electrical discharge.

The basis of the experiment he designed was a simple application of the results of his laboratory investigations. He would make use of the properties of pointed conductors which he and his associates had discovered in their laboratory experiments. In the experiment he designed he planned to erect a long metal rod ending in a point. A grounded wire could be brought into contact with this rod – either directly or through a Leyden jar (or capacitor) – and thus enable an experimenter to find out whether he could "draw off" electrical fluid from passing clouds, just as Franklin had done on a smaller scale in his laboratory. Since it might be damp weather, he planned to have the experimenter situated in a small house or shelter, such as a sentry box. The grounded wire would be led onto the sentry box and the rod would protrude from a window or other opening. In the simplest form of the experiment, the operator could bring these two conductors into contact, whereupon a spark would prove that clouds are electrified. The inference could then be made that the lightning discharge is indeed an electrical phenomenon.

Franklin's reasoning led him to yet another conclusion, one of real significance in history. If a grounded pointed conductor could actually draw off the electrical charge of clouds, then here was a way to get rid of the charge in passing clouds, "silently" as he said, "drawing off their electric fire." Thus his theoretical and experimental laboratory work led him to invent the lightning rod.

In passing, let me observe that in practice, as Franklin found when lightning rods began to be erected, the rods acted in a different and more important way. They would attract a stroke if there was one and safely conduct it into the ground, thus saving the church or other public building, home, or barn.

In *Experiments and Observations*, of which the first part was published in 1751, Franklin described this proposed experiment. Franklin was hoping to make this experiment using the large cupola of Christ Church in Philadelphia as his sentry box. At the time of publication, the cupola was still under construction. This cupola differs from many belfries in that it contains a room just the right size and suitably high for making the experiment that Franklin proposed.

Franklin's book was rapidly translated into French and the many experiments he described were performed before the king of France. There was, of course, great interest in knowing whether or not the experiment of the clouds would succeed. To this end, the translator of the book, Jean d'Alibard, and another experimenter named Monsieur Delor (or De Lor) each set up an apparatus much like the one Franklin had described. They soon reported the successful outcome of their experiments. Franklin was right. The lightning discharge is merely a large-scale electrical phenomenon. Franklin received a special laudation for his originality from the king himself. Others quickly made similar experiments with the same positive result.

In the meanwhile, before he heard the news of the success of the French experiments, Franklin thought of another way of getting a pointed conductor up into the air – the celebrated kite experiment. This was an afterthought, but it was easier to perform than erecting a special structure. I have found some fifty instances of the repetition of this experiment in the eighteenth century.

The full significance of Franklin's lightning experiments and his invention of the lightning rod is not generally understood. Franklin's contemporaries hailed the lightning experiments, as they came to be called, for a number of reasons. First and foremost, they showed that the kind of "toy-physics" experiments made in the laboratory were part of the normal operation of nature. They did not result from the interposition of artifice into nature. Rather, they differed only in scale from one of the most gigantic forces of nature – manifested in thunder and lightning. Hence it followed that no natural philosophy or system of physical science could be considered complete unless it includes electricity as part of the science of nature.

Second, the invention of the lightning rod showed that the pursuit of pure science, the search to understand the basic phenomena of nature, would lead to practical innovations. When Franklin began the study of electricity, it was not a practical subject. Indeed, the only known use of electricity was medical – giving shock-therapy treatment to patients suffering from paralysis. Franklin pointed out that any improvement came most likely from the patient's exercise in getting to the electrical laboratory or from the force of mind, the hope that the shock would help cure the paralysis.

Incidentally, although such practical outcomes of pure or basic science had been predicted by both Descartes and Bacon, there had never been a major example until Franklin's invention of the lightning rod. As late as 1830, this case history was still being cited as the primary proof that science should be supported because basic knowledge leads to practical applications beneficial to mankind.

Third, and perhaps most important from the point of view of the eighteenth century, Franklin's study of electricity and the invention of the lightning rod dealt a major blow to superstition. No longer need it be believed that lightning was an explosion of the forces of darkness or that lightning was a warning to sinners from an angry god. We may recall that in those days it was customary to ring church bells during lightning storms; the bells actually had inscribed on them the phrase *fulgura frango* (I free the air of lightning). We may understand why Franklin took delight when he found out that clouds (or the lower parts of clouds) were often negatively charged and not always positively charged. Hence, it would follow that lightning was not exclusively a set of thunderbolts sent from the heavens to the earth but could also be a set of thunderbolts from the earth sent into the clouds. He also found records of a high rate of mortality among bell ringers, killed by lightning strokes while ringing the church bells during thunderstorms.

The first edition of Franklin's book was published in London in three parts (1751, 1753, 1754). A second edition (1754) consisted of only parts one and two, while a third edition (1760, 1762, 1765) contained all three parts. The first edition to be corrected and edited by Franklin was the greatly expanded fourth edition (1769), followed by a fifth edition (1774). For details, see the 1941 edition cited below.

Bibliographic Note Further information on Franklin's scientific career and the significance of the lightning experiments can be found in my *Benjamin Franklin's Science* (Cambridge: Harvard University Press, 1990); a detailed analysis of Franklin's research in electricity is given in my *Franklin and Newton: An Enquiry into Speculative Newtonian Experimental Science and Franklin's Work in Electricity as an Example Thereof* (Philadelphia: The American Philosophical Society, 1956; Cambridge: Harvard University Press, 1966). An evaluation of Franklin's contribution to electrical science against the background of the times is given in John L. Heilbron: *Electricity in the Seventeenth and Eighteenth Centuries: A Study of Early Modern Physics* (Berkeley/ Los Angeles: The University of California Press, 1979). Franklin's revised text is available in a modern edition in *Benjamin Franklin's Experiments; a new edition of Franklin's Experiments and Observations on Electricity* (Cambridge: Harvard University Press, 1941). On the dating of Franklin's letters, see "Some Problems in Relation to the Dates of Benjamin Franklin's First Letters on Electricity," *Proceedings of the American Philosophical Society* (Library Bulletin) 100 (1956): 537-544.

I. Bernard Cohen

Benjamin Franklin ***Experiments and Observations on Electricity***

I. Bernard Cohen (born 1914) is the leading disciple of George Sarton, founder of the academic study of the history of science. His entire scholarly career has been spent at Harvard, where he is at present Victor S. Thomas Professor of the History of Science Emeritus. The scientific studies of Franklin and their relations to society have been a constant theme in his studies, from his first book, an edition of *Benjamin Franklin's Experiments* (Harvard, 1941) with historical commentary, to his recent *Science and the Founding Fathers* (Norton, 1995), an account of the interrelation of science and politics among Jefferson, Adams, and Franklin.

Binding

The binding of *Experiments and Observations on Electricity* is of contemporary brown sheep over pasteboard measuring 9" x 7 ¼" (229 mm x 184 mm). The front and back boards have gold double-rules on the four edges. The spine, which has been rebacked with calf, is divided into six panels with a new dark red leather title label on the second panel.

Click here to see binding

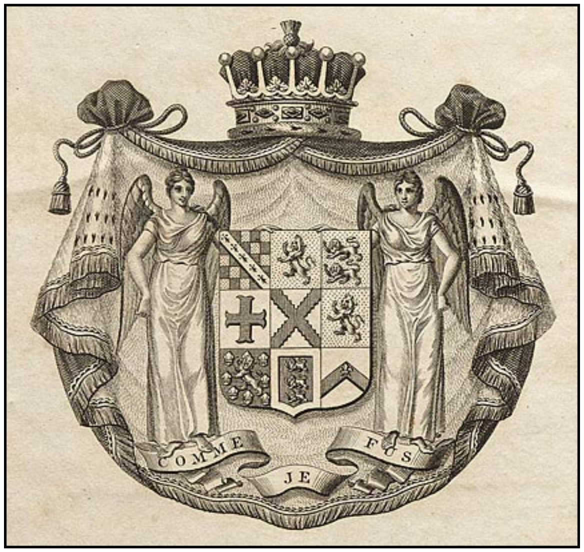
Collation 4^0: *A*^{2}, B-L^4, M^4 (-M4), χ^2, N-O^4, P^4 (-P4), 2χ^2, Q-U^4, X^2 [$2 (L2 signed L, -P2, +Q3, -X2)], 82 leaves, pp. [*4*] 1-86 [*2*] 87-110 [*4*] 111-154 [=154] (page 79 misnumbered 76; page 109 misnumbered 107; pp. 1, 50, 87-89, 93, 108-111, 130, 143, 153 unnumbered).

Contents: ***A*1**^{a}: printed title. **A1**^{b}: blank. **A2**$^{a-b}$: preface. **B1**^{a}-**C1**^{a}: Letter I. **C1**^{b}-**D1**^{b}: Letter II. **D2**^{a}-**F2**^{a}: Letter III. **F2**^{b}-**M3**^{b}: Letter IV. χ**1**$^{a-b}$: advertisement. χ**2**^{a}: title - Part II. χ**2**^{b}: blank. **N1**^{a}-**N2**^{b}: Letter V. **N3**^{a}-**O1**^{b}: Letter VI. **O2**^{a}-**O3**^{a}: Letter VII. **O3**^{b}: Letter VIII. **O4**^{a}-**P1**^{b}: Letter IX. **P1**^{b}-**P2**^{b}: Letter X. **P2**^{b}-**P3**^{a}: Letter XI. **P3**^{b}: errata. **2**χ**1**^{a}: title - PART III. **2**χ**1**^{b}: blank. **2**χ**2**$^{a-b}$: contents. **Q1**^{a}-**S1**^{a}: Letter XII. **S1**^{b}-**S2**^{a}: Letter XIII. **S2**^{b}- **T4**^{b}: 'Remarks on the Abbe Nollet's Letters on Electricity'. **U1**^{a}-**X1**^{b}: Experiments. **X2**$^{a-b}$: appendix.

Plate: Fig. I-X opposite K4b.

Provenance

The bookplate is that of John William Ward (1781-1833), later (1823) 9th Lord Ward and 4th Viscount Dudley & Ward, and still later (1827) 1st Earl of Dudley of Castle Dudley, Staffordshire. The coronet at the top is an earl's and not a viscount's: the bookplate therefore was engraved between his elevation in 1827 and his death in 1833. *Comme je fus* (As I was) is the motto of the Ward family. Their arms appear in the upper lefthand corner of the shield; the various others – Sutton, Somery, Lexington, Tiptoft, Charleton, Holland, and Plantagenet – belong to an assortment of Ward's ancestors. He held various parliamentary offices and a cabinet post under George Canning and the Duke of Wellington.



There is no record of his ever having had a taste for electrical researches, but a gentleman's library is by tradition allowed to contain books that its owner has no intention of reading. As a scholar and a wit, Ward may well have relished Franklin's humor, and in his early days as a Whig (1804-17) he may even have approved of his politics. Ward was elected a Fellow of the Royal Society in 1815, which may suggest at least the scientific interests of a dilettante, although until the reforms of the late nineteenth century, the Society was not composed exclusively of scientists, as it is today – social connections were still invaluable in an age of aristocratic (rather than bureaucratic) patronage.

Ward was eccentric and often talked to himself in dialogue, one voice low and gruff, the other piercingly shrill. At first contemporaries amused themselves by pretending that this merely reflected the split personality of a binomial (or double-barreled) peer, observing that "It is only Dudley talking to Ward." But his absence of mind became more marked. "On a certain Wednesday," according to the waspish J.W. Croker, "he told Mr. Murray, the bookseller [and publisher], to advertise his library for sale, and next day consulted him about buying a larger additional one. In short he shows every mark of harmless derangement…." Eventually, Ward was placed in an asylum, where he died after a little less than a year of confinement.

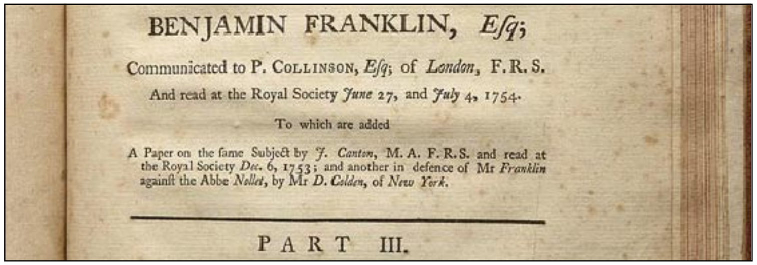
Two collections of his agreeable, amusing, and often bookish letters have been published: the slightly stiff *Letters of the Earl of Dudley to the Bishop of Llandaff* (1840), edited by the Bishop who was his Oxford tutor, Edward Copleston, a masterly satirist; and the much more vivacious *Letters to "Ivy" from the First Earl of Dudley*, edited by S.H. Romilly (1905) – "Ivy" was Helen D'Arcy Stewart, wife of Ward's sometimes private tutor, the eminent Scottish philosopher Dugald Stewart, from whom he is said to have contracted his unsettling habit of soliloquizing.

Spots on the Page

The rust-red spotting of the paper in this copy of Franklin's *Experiments…on Electricity* is known as "foxing." The name is, of course, suggested by the fur color of the animal. Most American books of the eighteenth century and especially the early nineteenth century tend to be foxed, far more so than books produced, for instance, in England at the time.

Foxing is only one of the many possible disfigurements of paper that result from variations in temperature and humidity, infection, or physical abuse, either during its manufacture, printing, or subsequent handling. Paper may be: browned by contact with acidic residue (either during the process of manufacture or by being placed in contact with certain leathers as endpapers in a book); stained by offsetting from the ink of an adjacent illustration, or by shadows from a facing block of text; discolored by spills or sloppy decoration of the page edges that leave a brown tide-line in drying; or completely disintegrated by mold. These afflictions have readily apparent causes; foxing, however, is more subtle and complicated, apparently involving fungi and mineral deposits. Investigation of its cause is complicated by the immense range of environmental variables, especially moisture, and the still greater variety of fungi. At least a hundred species are known to flourish on paper; roughly half of these have been found in suspicious conjunction with foxing.

"Foxing" itself is not, in fact, a precise term and has been used to describe a range of damage and discoloration. And not all fungal damage can be called foxing – this is especially true of infections resulting from the moisture of the tropics. Some foxing (as disclosed by the electron microscope) is clearly fungal in origin, and other related forms of spotting are probably physical – some interaction also seems likely. Although fungi produce variously colored pigments, none has yet been isolated to match the characteristic rusty-red of foxing. Residual minerals in the paper – iron or copper, for example, from the water, rags, wood pulp, or machinery involved paper production – may only form spots of discoloration under the action of malic and amino acids secreted by the fungi and affecting the cellulose and size. On the other hand, a fungal infection in environmental circumstances that happen not to foster discoloration will not be classified as "foxing," however closely related it may otherwise be. This combination of paper, environment, and fungi may be put in the simple restaurant terms of food, atmosphere, and patrons, but the precise recipes remain in dispute after more than half a century of intermittent research.



BENJAMIN FRANKLIN, *Eſq;*

Communicated to P. COLLINSON, *Eſq;* of *London*, F.R.S.

And read at the Royal Society *June* 27, and *July* 4, 1754.

To which are added

A Paper on the ſame Subject by *J. Canton*, M. A. F. R. S. and read at the Royal Society *Dec.* 6, 1753; and another in defence of Mr *Franklin* againſt the Abbe *Nollet*, by Mr *D. Colden*, of *New York*.

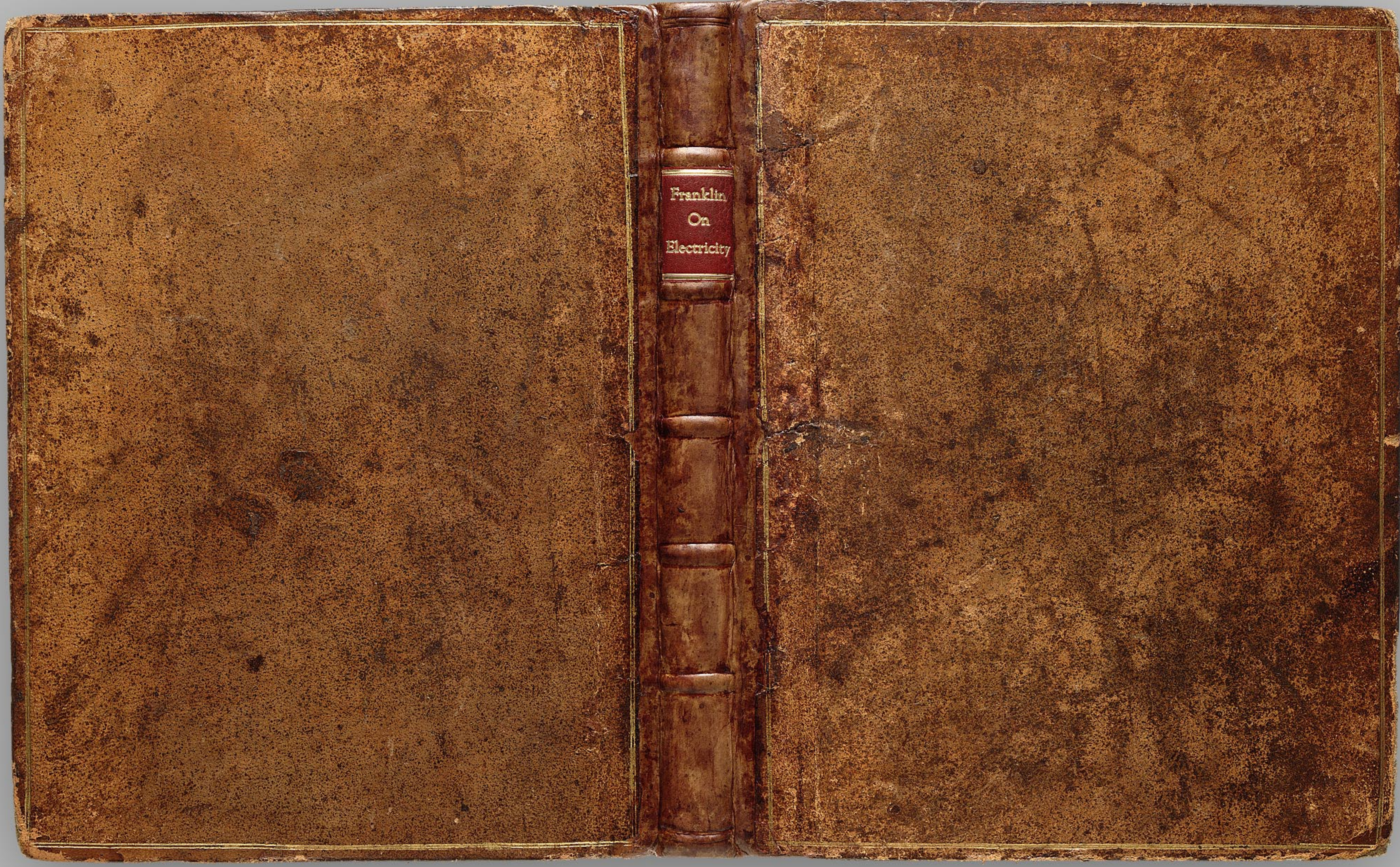
PART III.

Currently, biology is starting to win out over chemistry, the mycologists over the mineralogists, but this is partly a result of more precise terms of reference. Booksellers have long distinguished between "spotting" and "foxing" in their descriptions, between "papier piqué" and "rousseurs," albeit not always consistently, and on purely aesthetic grounds. Conservators have since come to recognize, on scientific grounds, that spots with a dark center and concentric rings do contain a central iron fragment and represent a form of mineral spotting quite distinct from the more common irregularly shaped light brown or rusty areas, lacking any central point, that booksellers have traditionally considered to be "foxed." These last tend to have a higher concentration of acid and iron than the surrounding paper but also tend to show signs of fungal growth.

Clearly more research into the influence of pH, relative humidity, temperature, and metallic trace elements is essential – but the conservator must begin to work with the historian, or the epidemiology of biodeterioration will remain incomplete. The large and contradictory literature on foxing entirely lacks a historical dimension. Many a bookseller who has handled dozens of copies of a particular title over the years has come to recognize that certain volumes, or books printed by certain printers, at certain times are extraordinarily subject to foxing and others strikingly free. And yet, a comprehensive historical study of foxed books – arranged by type and source of paper; date, place, and manner of printing; and location and conditions of subsequent storage – has never been attempted. In large part, this is owing to the framework within which the subject tends to be investigated. Just as funding for medical research (charitable and otherwise) is influenced by the nature of the disease and the position of the sufferers in society, research on foxing, "a fungal infection of paper" (to adapt the title of the only scientific study of the subject by a bookseller), is determined by the fact that damage to a unique work of art – a minute blemish on a Rembrandt drawing – justifiably attracts more attention than stray marks that do not impair the legibility of a commonplace book. To many people, even museum-goers, a book remains no more than a text.

Foxing is indeed a defect to museum curators and art historians, a failing to be corrected or prevented. To the bibliophile, the connoisseur of books, it is something more complex – undesirable to be sure – but not necessarily in need of a "cure," and an historical and aesthetic rather than a mycological phenomenon. Certain tastes, those associated with the classic French tradition of bibliophily, for instance, still share the vision of the nineteenth-century museum director. A book (like a painting) is to such tastes most beautiful, and best looked after, when meticulously cleaned, refurbished, retouched, and reframed – all at great expense, to accord with its present luxurious surroundings rather than its possibly more humble origins. Other cultures and traditions are averse to cosmetics, more sensitive to original condition and the patina of age. A clean copy remains desirable, but not one that has *been* cleaned. Other forms of biodegradation, rot, mildew, or water staining – to say nothing of wormholes – are in a different class: they suggest exceptional carelessness or even abuse rather that the natural progress of time.

The delightful Franklin of legend, the sprightly sage, would have made himself ridiculous with a face-lift or hormone treatments. It would be just as grotesquely inappropriate to bleach and rebind this copy of his *Experiments*. To a connoisseur with an historical sense of nuance and terroir, a little foxing is simply an inevitable deposit in certain books, a sure sign of bottle-age.



Benjamin Franklin. *Experiments and Observations on Electricity*. London, 1751. THE WARNOCK LIBRARY

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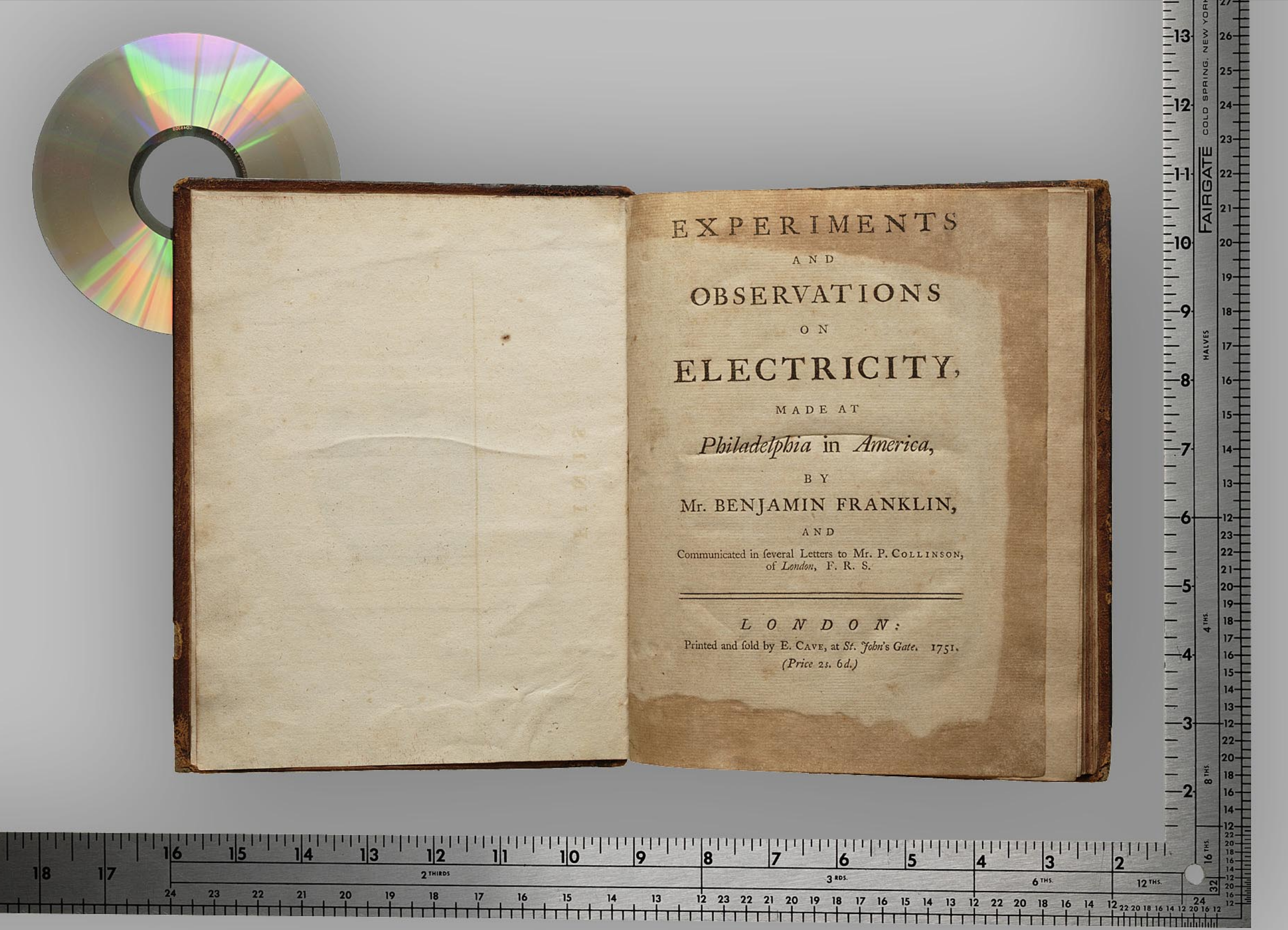

FAIRGATE
COLD SPRING, NEW YORK

EXPERIMENTS
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ON
ELECTRICITY,
MADE AT
Philadelphia in *America*,
BY
Mr. BENJAMIN FRANKLIN,
AND
Communicated in ſeveral Letters to Mr. P. COLLINSON,
of *London*, F. R. S.

LONDON:
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